matter of fact we do see some very long lines in this way in the case of some substances, and these of course appear to be quite distinct from the shorter lines which are limited to the exact centre of the spark or the arc ; to the region, that is, in which the very highest temperature is at work. Rydberg has shown that in a considerable number of cases long lines seem to have a very considerable importance, and on that account it is well worth inquiring into. Rydberg's investigations of the members of the first three groups of the periodic system led him to conclude that the long lines form pairs or triplets, which in the case of each element are characterised by a constant difference (v) in the number of waves of the components. For each group of elements shown in Mendeléjeff's table, this value he finds increases in a ratio somewhat exceeding the *square* of the atomic weight.

What, then, is the general result of our inquiry, taking series in inorganic evolution to represent the cells which are microscopically studied in the case of organic evolution? I think you will agree that the evidence is that, however simple the organic cell may be, the chemical units in the case of any substance represented to us by the movements which are written out by these series must possess different degrees of complexity. I have already told you that a little time ago it was imagined that hydrogen was rendered visible to us by such simple vibrations that only one series of lines could be produced. If that is so, then it looks very much as if whenever we see three series of lines that three molecules or atoms, three different things, are in all probability at work in producing them. When we get six series, that points to a still greater complexity, and when as in the case of oxygen we get six series not accounting for half the lines, then we should be quite justified, I think, in supposing that oxygen was one of the most complex things that we were brought face to face with in our studies of series. When we come to metals where there are no series at all, what do we find? We find that we are dealing with substances with high melting points—that is to say, we cannot bring them down easily to those mobile states represented by the free paths of a permanent gas ; and it is quite easy to suppose, on that account alone, that we do not see the vibrations of any of the more simple forms. Therefore, I think it is perfectly certain that we have not universally got down to the equivalent of the cell-level in our study of chemical forms.

With regard to this question of the relation of the two evolutions inorganic and organic, I have still one more diagram which will give an idea of the place of organic evolution in regard to inorganic evolution in the scale of time. I do not want you to pay too much attention to this diagram, because it is entirely hypothetical ; but it is constructed on the simplest principles, so that it shall go as little wrong as may be. I begin by drawing a line at the bottom, which represents the zero of temperature ; certain temperature values are indicated on the left-hand side of the diagram. Then we have the assumption that a star loses an equal amount of heat in an equal period of time. In that way, then, you see at the bottom we have relative times, as at the side we have temperatures, in Centigrade degrees. Water freezes at a certain temperature above absolute zero, and boils at a certain other point ; these are marked on our temperature scale. Then we have to remember that about half-way between the boiling point and the freezing point, all the organic life with which we are familiar on this planet, from the geological evidence and our own experience, must have gone on at a temperature of somewhere about, let us say, from 50° to 40° Centigrade. There, then, we get the limit of organic life in relation to the possible inorganic life, represented by the various chemical changes in the stars. We know from laboratory statements that the stars of lowest temperature are about the same temperature as that of the electric arc, which is about 3500° C., and so we put the Piscian stars there. It has also been stated by Mr. Wilson lately that the temperature of the sun measured by several physical methods is something between 8000° and 9000° C., so that we put there the Arcturian stars. Of course we have no means of determining the temperatures of the hotter stars, so I have ventured to make a very modest supposition that possibly we get about half the difference of temperature between those stars as we have found between the Piscian and the Arcturian stars from experiments on the earth. That will give us roughly something like 5000° C. We find then that if we assume equal increments of temperature for each of the different genera of stars that I brought before you in the second lecture, we get a temperature at the top of the diagram of something like 28,000° Centigrade. All we have to do, then, is to draw a diagonal line on which to mark the various temperatures considered. On this the organic evolution, which represents everything which has taken place with regard to living forms on the surface of our planet from the pre-Laurentian times to our own, is represented by a small dot. It looks, therefore, very much as if these recent results of spectrum analysis, which it has been my duty and my pleasure to bring before you in this course of lectures, may probably be of some value in the future, because they deal with a multitude of changes and a period of time compared with which all the changes discussed by the geologists are almost invisible on a diagram of this size. Not only shall we have probably some help in determining this scale, but I think that, as I have already indicated to you, the wonderful similarity between the substances contained in the organic cell and those which would most likely be free when the greatest amount of chemical combination had taken place on the surface of the cooling world, will throw some light on the basis of organic evolution itself.

In that way, then, we have really been only continuing courses of lectures given here formerly, which had to do with Man's Place in Nature, and with the Sun's Place in Nature ; and I think you will agree that we have found fresh grounds for thinking that the more different branches of science are studied and allowed to react on each other, the more the oneness of Nature impresses itself upon the mind.

NOTE ON THE DISCOVERY OF MIOLANIA *AND OF* GLOSSOTHERIUM (NEOMYLODON) *IN PATAGONIA.*[1]

SINCE 1877, when I discovered the Tertiary Mammalian beds of Santa Cruz, in Patagonia, I have been looking for proofs of the ancient connection between the new uplifted lands of the southern part of the American continent and the other lands of the Southern Hemisphere—Africa and Australia. During my subsequent travels in the interior of the Argentine Republic, including Patagonia, my interest in that connection has been increasing, and I have discovered additional evidence, which showed me the former greater extension to the east, in comparatively modern times, of the actual existing lands. The splendid results of the researches made by the La Plata Museum in Patagonia have revealed a greater number of lower forms of vertebrates, including numerous marsupialia, some of which seem to me closely related to the mammals of the Pleistocene fauna of Australia, and among them *Pyrotherium* and *Diprotodon.* I think that my suggestion has an indubit-

[1] By Dr. Francesco P. Moreno, Director of the La Plata Museum.
(This article will appear in the *Geological Magazine* for September 1, and is printed in advance in NATURE, by permission of Dr. H. Woodward, F.R.S.)

able confirmation in the discovery made by the expeditions which I sent in 1897 and in the first months of this year, under the direction of Mr. Santiago Roth, expeditions that have had astonishing results.

In beds containing remains of mammals and dinosaurians, Mr. Roth discovered in 1897 a caudal sheath-ring, very similar to those of the *Glyptodon*, but which I at once recognised as pertaining to a form like the chelonian of the Pleistocene of Queensland, described by Owen. I brought this fossil with me to London for comparison with the remains of *Miolania* preserved in the British Museum (Natural History). The resemblance was great, but the fact of a Tertiary chelonian from Patagonia being analogous to the Pleistocene genus from Queensland and Lord Howe Island was so astonishing that some doubt was permitted; but, having previously ordered a new examination of the fossiliferous bed where the remains were found, I have now the certainty of the extremely close relation between the Australian and Patagonian chelonian. I have received several photographs of a skull discovered by Mr. Roth, which photographs, when compared with the Australian specimens in the British Museum (Natural History), give no place for doubt upon this matter. I think that it is sufficient for the present to give two cuts representing the two forms of *Miolania*. I expect in a few days the original specimen from Patagonia, together with various bones and additional remains of the caudal sheath, with some of the carapace. These will be the subject of a special description by Mr. Arthur Smith Woodward, who has so kindly commenced studies on the fossil reptiles in the La Plata Museum.

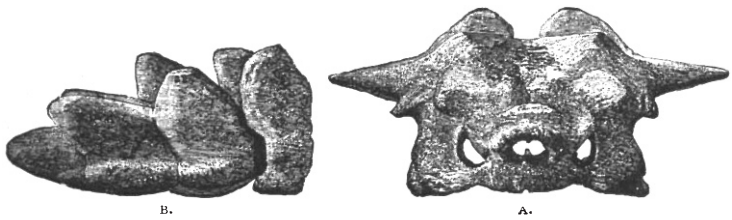

FIG. 1.—A, front view of skull; and B, side view of tail-sheath, of *Miolania Oweni* (greatly reduced in size) from Pleistocene deposits, Queensland, Australia [originally described as *Megalania prisca* by Owen in 1880].

I have also brought with me to London a piece of a skin discovered in a cave near Last Hope Inlet (lat. S. 51° 30′), which I have referred to a species of the extinct *Mylodon* (see "On a Portion of Mammalian Skin, named *Neomylodon listai*, from a Cavern near Consuelo Cove, Last Hope Inlet, Patagonia," by Dr. F. P. Moreno; with a description of the specimen by A. Smith Woodward); while Mr. Ameghino has announced that another piece of the same skin pertains to a mammal still living, of small size, which he has called *Neomylodon*. When I took this piece at Last Hope Inlet in November 1898, I was convinced that it was part of the skin of a *Mylodon* or a form very similar to it, and that the discovery was of great importance to me, as I think that the Pampean muds, where the extinct Edentata are found, are of very modern age; an opinion contrary to that held by another observer, Mr. Ameghino, who refers the Pampean fauna to the Tertiary age. I have already maintained that the extinction of the greater part of the Pampean fauna took place after the presence of man in a relatively advanced culture, called Neolithic culture. Having, then, great interest in the continuation of the investigations in the cave, I ordered, before coming to London, more extensive researches, and these have been made with very successful results.

Dr. Otto Nordenskjöld had previously obtained in 1896 a piece of the same skin, which, it is known, was discovered by a party of Argentine surveyors during the preliminary studies for the boundary between Argentina and Chili in the Andean Cordillera, and, recognising also the importance of it, Dr. Erland Nordenskjöld went last year to the same spot to look for some more remains. The excavations which he made gave him, so far as I know, some bones, pieces of jaws, teeth, and claws of the same animal, but he did not obtain more remains of the skin.[1] My assistant, Mr. Hauthal, arrived later at the cave, when Dr. Erland Nordenskjöld had terminated his researches and commenced further exploration. He obtained, not only skulls, jaws, teeth, bones and claws, but also a nearly complete skin of the animal, which shows that it is a *Glossotherium*, together with bones of *Macrauchenia*, *Equus*, and *Auchenia*, also a great quantity of dung, hay cut by man, ashes, and some bones worked by man. I am not yet sure if the bones of man discovered by Mr. Hauthal were found in the same cave or in one of those in its neighbourhood; but the presence in the *Glossotherium* deposit of bones worked by man is a proof that man and other mammals, whose remains have been discovered in the cave, were contemporary. I suggest that the skin has been preserved by man for bedding. In the caves inhabited by ancient man in Patagonia I have seen cut hay, and probably this also was used for beds.

I expect to receive in a few days all these specimens at the same time as those of the *Miolania*, together with reports on the discoveries, and I think they will arrive in time for me to exhibit these remains at the meeting of the British Association at Dover.

The discovery made by Mr. Roth of some advanced Mammalia in the beds that contain dinosaurians, and Mr. Hauthal's discovery of remains of extinct vertebrates and other mammals in the caves of Southern Patagonia, associated with *Macrauchenia*, *Equus*, *Auchenia*, and man, are proofs of the very recent changes in the physical geography of Patagonia, and afford most interesting problems, which can only be solved by a systematic examination of the Argentine country by experienced geologists. In the course of my paper on Patagonia, read before the Royal Geographical Society (May 29), I proposed that this Society, the Royal Society, and the British Museum, with other scientific institutions, should proceed to carry out these necessary investigations. These problems are not extraneous to the explorations which may be carried out by an Antarctic

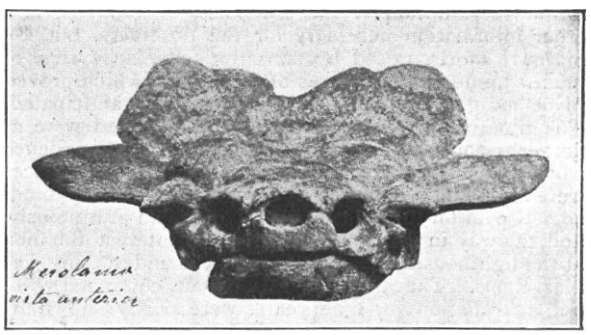

FIG. 2.—Reproduction of a photograph of the front view of skull, with the lower jaw, of *Miolania*, obtained in 1899, from Patagonia, by Mr. Santiago Roth, of the La Plata Museum, Argentine Republic (greatly reduced in size).

[1] "E. Nordenskjöld, Neue Untersuchungen über *Neomylodon listai*, Zool. Anzeiger," vol. xxii. (1899) pp. 335–336.

expedition, and I think the new discoveries which I now communicate to the *Geological Magazine* may urge on the despatch of such expeditions as I propose. If these expeditions be made, how many changes may be produced in actual and general ideas on the age of the South American fossiliferous strata, on the disappearance of the lost southern lands, and on the affinities of extinct faunas so distant in time and space as those of South America and Australia!

MR. JOHN CORDEAUX.

BY the death of Mr. John Cordeaux, ornithology loses, not only one of its most ardent votaries, but one who had pursued, if he did not strike out for himself, a line very different from that taken by most British lovers of birds. For nearly six-and-thirty years, as shown by a long series of contributions, chiefly to *The Zoologist*, he applied himself to the study of the phenomena of bird-migration, at first as exhibited on the coasts of Lincolnshire (in which county he lived) and Yorkshire. This led him in the autumn of 1874 to go to Heligoland for the sake of comparing notes with the now well-known Herr Gätke, whom, it is believed, he was the first British ornithologist to visit; and he soon after wrote for *The Ibis* (1875, pp. 172-188) a notice of the very wonderful collection formed by that naturalist on that island. In 1879 he joined Mr. Harvie-Brown (who had just communicated a remarkable paper to the Natural History Society of Glasgow) in a successful attempt to procure observations on migrating birds from the keepers of lighthouses and lightships on the coasts of England and Scotland; and in the following year, when the results of their inquiry were brought before the British Association at the Swansea meeting, he was named secretary of a committee appointed to continue systematically the scheme which they had shown to be practicable. Of this committee, which (with a slight variation of title) has since been annually reappointed, he has always been the hardworking secretary, and it is not too much to say that nearly all its success is mainly due to him. He not only arranged with the authorities for the distribution of the schedules, instructions, and other information necessary for the observers, but, by his own efforts, raised by subscription a large sum of money to meet the expenses of the inquiry, which proved to be far greater than had originally been anticipated. The time and trouble which all this involved were at first enormous; and, even to the last, the correspondence which he had to carry on was immense, yet his services were as willingly rendered as though he had been handsomely paid for them, instead of giving them gratuitously, and the way in which he contrived to interest the men at the lighthouses and lightships in the undertaking was marvellous. The results of this labour, continued without intermission for nine years, were partly shown by the admirable "Digest of the Observations," made by Mr. W. Eagle Clarke, which the committee was able to include in its report presented to the Association at Liverpool in 1896; and, as has been announced, that gentleman is still occupied in working out further details from the mass of materials that has been collected.

Mr. Cordeaux made more than one visit to Heligoland, and is understood to have been instrumental in bringing about the publication of an English translation of Gätke's celebrated work, though never committing himself to the adoption of his friend's views on many points. Indeed, he abstained on principle as much as possible from advocating any theories on the subject of migration, being convinced that much more knowledge had to be acquired from observation before more than a few first principles could be safely accepted. That he was the life and soul of the Migration Committee is beyond all doubt. His happy tact and sanguine temperament overcame all difficulties, though—especially from the financial point of view—they were at times so formidable as to threaten the abandonment of the work; yet by his care funds were always found to carry it on, eking out the successive and by no means illiberal grants of the British Association. He is said to have been very successful as a lecturer, and he often lectured on some ornithological subject, especially on the migration of birds, in the towns of Yorkshire and other parts of the country.

Forty papers are credited to Mr. Cordeaux in the Royal Society's Catalogue up to 1883, a number which might possibly be doubled now, and in addition to these he was the author of an unassuming but well-written little book, "Birds of the Humber District," published in 1872, a new edition of which it had been his intention to bring out. He died, after a short illness, at his residence, Great Cotes House, in Lincolnshire, on August 1, in the sixty-ninth year of his age, deeply lamented by all who had been associated with him in the work he so indefatigably carried out. A. N.

NOTES.

WE much regret to record that the serious illness of Prof. R. W. Bunsen, referred to in last week's NATURE, has ended fatally. An account of the chief work of this world-renowned chemist appeared nearly twenty years ago in our Series of Science Worthies (vol. xxiii.), and we hope to publish a further appreciation of the deceased investigator next week.

THE funeral of Sir Edward Frankland took place at Reigate on Tuesday. There were present, in addition to the immediate relatives, Sir Frederick Bramwell, Lord Lister, Sir Henry Roscoe, Sir Myles Fenton, Sir Michael Foster, Dr. Ludwig Mond, Dr. Thorpe, and others. The Rev. Prof. Bonney conducted the funeral service. Many wreaths adorned the coffin, including one from the Fellows of the Institute of Chemistry and one from the Chemical Society.

MAJOR RONALD ROSS, the leader of the expedition sent to Sierra Leone by the Liverpool School of Tropical Diseases to investigate the possibility of exterminating the malaria-bearing mosquito, has sent to Liverpool the following cablegram: "Malarial mosquito found. Ask Government to send at once men." Major Ross's observations in India indicated that the malaria parasite is borne by the spotted-winged mosquitoes, and not by the common brindled or grey mosquitoes; and his message announces that he has found that malaria on the West Coast of Africa is produced under the same conditions as in India. There is evidence that the malaria-bearing species only breeds in small isolated collections of water which can be easily dissipated, but the expedition has not yet had time to verify this point.

THE presence of bubonic plague in Portugal has been officially notified to the Local Government Board. Oporto has been declared to be infected, and the other ports of Portugal are considered suspected. Port sanitary authorities in this country have been instructed in the precautions to be observed to prevent the introduction or spread of the disease here.

IT is announced that Sir Edmund Antrobus is desirous of selling Stonehenge, the famous and mysterious monument on Salisbury Plain. Thinking it right that the nation should have the opportunity of purchasing this great relic of antiquity, the owner has offered it to the Government, with about 1300 acres of surrounding land (subject to certain pasturage and sporting rights), for the sum of 125,000*l*.